Remarks

Claims 1, 2, 14, 17, and 18 are pending and are rejected.

Claim 18 is cancelled.

Claims 1 and 14 are amended to include the limitation that the magnetic field establishes "a convection which is initially directed to a bottom of the crucible." The antecedent basis for these amendments is found on page 5, ll. 16-18 of the Specification. Claims 1 and 14 are further amended to clarify that the magnetic field "exerts a substantially vertically downward oriented force on the melt. . ." The antecedent basis for these amendments are found on page 9, l. 20 to page 10, l. 2 and page 10, ll. 18-20 of the Specification. Claim 17 is amended to replace "upwardly" with "upward." No new matter is added.

The Specification is amended on page 5, l. 17 to replace "base" with "bottom." These terms have equivalent meaning. Moreover, both words are acceptable translations of the word "Tiegelboden" which was the term used in the original application.

Claim Rejections Under 35 U.S.C. § 103

Claims 1, 2 and 17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Iida et al. (U.S. Patent No. 6,077,343) in view of Haida (German Patent No. DE 3701733 A1). For clarity, German Patent No. DE 3701733 is referred to as Haida 1.

Applicants respectfully traverse the rejections of claims 1, 2, and 17 under 35 U.S.C. § 103(a) Iida et al. and Haida 1 for the reasons set forth below.

The present invention provides a method for producing silicon single crystals having diameters of at least 200 mm with an improved yield. Since large melt volumes are needed

to grow such single crystals, independent claims 1, 14, and 17 require that crucibles diameters of at least 450 mm are used. Claims 1, 14, and 17 further disclose a process in which a melt is subjected to a traveling magnetic field to attenuate low-frequency temperature fluctuations. Such low temperature fluctuations tend to cause dislocations, which are of course undesirable. Advantageously, the present invention provides a method for controlling the oxygen concentration as exemplified by claim 2. Finally, the claimed invention provides a method which allows growing the single crystals with increased pulling rates and with an enlarged radius for the OSF ring.

The Examiner concedes that "Iida et al does not teach using a traveling magnetic field" as required by each of independent claim 1. (Office Action dated February 2, 2006). It is therefore also apparent that Iida does not disclose "a traveling magnetic field which **exerts a substantially vertically downward oriented force** on the melt in a region of the crucible wall" as now required by amended claim 1. Finally, Iida also fails to disclose the use of a magnetic field that establishes "a convection which is initially directed to a bottom of the crucible" also required by amended claim 1.

The Examiner relies upon Haida 1 to provide the missing limitation of Iida regarding the use of a traveling magnetic field. However, Haida 1 fails to disclose the limitations set forth above in amended independent claim 1.

Applicants have explained in detail the differences between Haida 1 and Haida 2 (in the Appeal Brief these reference were referred to as the Aratani references) Haida 1 discloses a method for pulling silicon single crystals and subjecting the melt to a traveling magnetic field. A stated object of Haida 1 is "to minimize the dissolution of oxygen from silicon dioxide material of the crucible" (Haida 1, col. 3, ll. 33-35). Haida 1 accomplishes this objective by "applying the traveling magnetic field which serves for further suppression of the undesirable thermal convection flow 10, without reducing the forced convection flow 11 (Haida 1, col. 4, ll. 32-35).

Haida 1 further states that the forced convection flow 11 is caused by the rotation of the single crystal and is responsible for a uniform radial distribution of dopants. Specifically, example 1 of Haida 1 states that "the melt 4 was subjected to a downward traveling magnetic field of 100 Gauss in the close vicinity of the walls of the crucible 3." (Haida 1, col. 5, ll. 39-44). The results of this example:

> ...clearly reveal that subjecting the silicon melt to a traveling magnetic field was effective to reduce the concentration of oxygen to ¼ of that which was found in the absence of the traveling magnetic field, probably because a reduced dissolving of oxygen from the crucible forming silicon material as a **consequence of the suppression of the thermal convection** of the melt by the traveling magnetic field...
>
> (Haida, col. 5, l. 64-col. 6, l.5). (translations provided by Applicants)

It is clear that the method taught by Haida 1 intends to reduce the thermal convection flow in the vicinity of the crucible walls by applying a downward traveling magnetic field and to reduce the incorporation of oxygen into the growing single crystal. However, Haida 1 does not teach **"to establish a convection which is initially directed to a bottom of the crucible"** as required by amended independent claim 1..

In contrast to the teachings of Haida 1, the features of the present invention lead to a convection which is directed toward the bottom of the crucible (Specification, p. 5, last paragraph) and has the contrary effect of that taught by Haida 1, i.e., **an increase** of the oxygen concentration in the single crystal (Specification, p. 12, example 2). Obviously, Haida 1 does not foresee or suggest that the situation becomes completely different for the pulling of a single crystal having a diameter of at least 200 mm out of a crucible having a diameter of at least 450 mm. Accordingly, Iida and Haida 1 even whether considered individually or in combination do not teach "to establish a convection which is initially directed to a bottom of the crucible"as required by amended independent claim 1.

Regarding independent claim 17, the Examiner states that "Haida et al. [Haida 1] teaches an upward traveling magnetic field of 100 Gauss." This assertion is not correct. Applicants respectfully request the Examiner to point out the lines in Haida 1 that support this contention.

Accordingly, for at least these reasons, claims 1, 2, and 17 are patentable under 35 U.S.C. § 103(a) over the combination of Iida et al. and Haida 1.

Claims 1, 2 and 18 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Iida et al. in view of Haida et al. (German Patent No. DE 3701811 A1). For clarity, German Patent No. DE 3701811 is referred to as Haida 2.

Claim 18 is cancelled render the rejection of this claim moot.

Applicants respectfully traverse the rejections of claims 1 and 2 under 35 U.S.C. § 103(a) Iida et al. and Haida 1 for the reasons set forth below. The deficiencies of Iida are set forth above and apply to the present invention with equal force. Haida 2 does not disclose a process in which "a convection which is initially directed to a bottom of the crucible" is established as required by amended claim 1.

Accordingly, for at least these reasons, claims 1 and 2 are patentable under 35 U.S.C. § 103(a) over Iida et al. in view of Haida 2.

Claim 14 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Iida et al. in view of Haida 1, or in view of Haida 2, as applied to claim 1 above, and further in view of Lari et al. (U.S. Patent No. 4,905,756) or Morishita et al. (Japanese Patent No. JP 61-029128).

For the same reasons as set forth above, none of the references cited by the Examiner disclose the invention of amended claim 14. The deficiencies of Iida, Haida 1, and Haida 2 are set forth above. The Examiner relies on Lari et al. and Morishita to provide the means of producing the traveling magnetic field. These later two references do not provide the missing limitation - "to establish a convection which is initially directed to a bottom of the crucible."

Accordingly, for at least these reasons, claim 14 is patentable under 35 U.S.C. § 103(a) over Iida et al. in view of Haida, or in view of Haida, and further in view of Lari et al. or Morishita et al..

Conclusion

Applicants have made a genuine effort to respond to each of the Examiner's rejections in advancing the prosecution of this case. Applicants believe that all formal and substantive requirements for patentability have been met and that this case is in condition for allowance, which action is respectfully requested. If a telephone or video conference would help expedite allowance or resolve any additional questions, such a conference is invited at the Examiner's convenience.

A payment of $120.00 is made herewith to cover the Petition fee for a one-month extension of time. Please charge any additional fees or credit any overpayments as a result of the filing of this paper to our Deposit Account No. 02-3978.

Respectfully submitted,

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